Original Article

Comparative Audit of Abdominal Aortic Aneurysm Repairs Using POSSUM Scores

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Abdominal aortic aneurysm (AAA) repairs represent a significant workload in vascular surgery in Asia. This study aimed to audit AAA surgery and evaluate the application of the Portsmouth Physiological and Operative Severity Score for the Enumeration of Mortality and Morbidity (P-POSSUM) in an Asian vascular unit for standard of care. Eighty-five consecutive surgical patients with AAA from a prospective vascular database from July 1996 to December 2001 in Sarawak were available for analysis. Comparisons between predicted deaths by P-POSSUM and observed deaths in both urgency of surgery categories (elective, urgent, emergency ruptures) and risk range groups (0–5%, > 5–15%, > 15–50%, > 50–100%) were made. No significant difference was found between the predicted and observed rates of death for elective, urgent and emergency AAA repairs. The observed mortality rates were 5%, 18% and 30%, respectively. The observed rates of death were also comparable to P-POSSUM predicted rates of death in the various risk range groups. The POSSUM score used with the P-POSSUM mortality equation is easy to use and applicable as a comparative vascular auditing tool in Asia. [*Asian J Surg* 2003;26(3):149–53]

Introduction

Vascular surgery is a relatively new surgical specialty in Asia.[1] Among the vascular diseases, abdominal aortic aneurysms (AAA) represent a significant proportion of the workload.[2,3] Nonetheless, there are few reported studies on the surgical management of AAA.[4–6] In this area of high-risk surgery, it is important to demonstrate comparable results of "young" units to established units.[7] The recent case in Bristol, UK, where two paediatric cardiac surgeons had unacceptably high mortality rates for a cardiac procedure for almost a decade and were unmonitored, has brought about accelerated urgency to provide data on the performance of doctors and hospitals to the public.[8] This has ushered in a new era of accountability in clinical surgery.

The Physiological and Operative Severity Score for the Enumeration of Mortality and Morbidity (POSSUM) is a scoring system designed for comparative audits. The POSSUM score was originally described by Copeland et al,[9] with 12 physiological (Table 1) and six surgical (Table 2) factors for scoring. In each patient, scores are allocated for these factors and applied to an equation to obtain a predicted mortality rate. A separate equation is used to obtain the predicted morbidity rate. The observed rate is compared with the predicted rate for evaluation. A modification to the predictor equation, while retaining the usage of the originally described 12 physiological and six surgical factors for scoring, was published as the Portsmouth-POSSUM (P-POSSUM) equation.[10] The authors claimed that the P-POSSUM equation produced a closer fit with the observed in-hospital mortality in low-risk groups, and the comparison was easier to apply using linear rather than exponential analysis.[10] The POSSUM score is currently the most appropriate of the validated, available scores for comparative surgical audits, inclusive of vascular surgery in the UK.[10,11] This score has been tested and found to be applicable in Asia.[12] This study aimed to extend the application of the P-POSSUM score for audits in high-risk AAA surgery in a developing Asian vascular unit for the assessment of the quality of care.

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Table 1. Physiological score (to be scored at the time of surgery)

	Score			
	1	2	4	8
Age (yr)	≤ 60	61–70	≥ 71	
Cardiac signs	No failure	Diuretic, digoxin, anti-anginal or hypertensive therapy	Peripheral oedema, warfarin therapy	Raised jugular venous pressure
Chest radiograph			Borderline cardiomegaly	Cardiomegaly
Respiratory history	No dyspnoea	Dyspnoea on exertion	Limiting dyspnoea (one flight of stairs)	Dyspnoea at rest (rate ≥ 30/min)
Chest radiograph		Mild COAD	Moderate COAD	Fibrosis or consolidation
Systolic blood pressure (mmHg)	110–130	100–109 131–170	90–99 ≥ 171	≤ 89
Pulse (beats/min)	50–80	40–49 81–100	101–120	≤ 39 ≥ 121
Glasgow coma score	15	12–14	9–11	≤ 8
Hb (g/100 mL)	13.0–16.0	11.5–12.9 16.1–17.0	10.0–11.4 17.1–18.0	≤ 9.9 ≥ 18.1
WBC count (x 10^{12}/L)	4.0–10.0	3.1–3.9 10.1–20.0	≤ 3.0 ≥ 20.1	
Urea (mmol/L)	≤ 7.5	7.6–10.0	10.1–15.0	≥ 15.1
Sodium (mmol/L)	≥ 136	131–135	126–130	≤ 125
Potassium (mmol/L)	3.5–5.0	3.2–3.4 5.1–5.3	2.9–3.1 5.4–5.9	≤ 2.8 ≥ 6.0
Electrocardiogram	Normal		Atrial fibrillation (rate 60–90)	Any other abnormal rhythm or > 5 ectopics/min, Q waves or ST/T wave changes

COAD = chronic obstructive airway disease; Hb = haemoglobin; WBC = white blood cell.

Table 2. Surgical score

	Score			
	1	2	4	8
Surgical severity*	Minor	Moderate	Major	Major +
Multiple procedures	1	2	> 2	
Total blood loss (mL)	≤ 100	101–500	501–999	≥ 1,000
Peritoneal soiling	None	Minor (serous fluid)	Local pus	Free bowel content, pus or blood
Presence of malignancy	None	Primary only	Nodal metastases	Distant metastases
Mode of surgery	Elective		Emergency resuscitation of > 2 h possible† Operation < 24 h after admission	Emergency (immediate surgery < 2 h needed)

*Surgery of moderate severity includes appendicectomy, cholecystectomy, mastectomy, transurethral resection of the prostate; surgery of major severity includes any laparotomy, bowel resection, cholecystectomy with choledochotomy, any peripheral vascular procedure or major amputation; surgery of major + severity includes any aortic procedure, abdominoperineal resection, pancreatic or liver resection, oesophagogastrectomy; surgery of minor severity includes all minor procedures not included in the other three categories of surgical severity. †Indicates that resuscitation is possible even if this period is not actually utilized.

Patients and methods

Vascular surgery was introduced to Sarawak in June 1996. The Malaysian state of Sarawak is on the Southeast Asian island of Borneo. It has a population of about 2 million, with five major ethnic groups, the Iban, Chinese, Malay, Melanau and Bidayuh. All patients with suspected vascular problems were referred to a surgeon for management.

A diagnosis of AAA was reached when the abdominal aorta measured 30 mm or more in diameter on ultrasonography in the anteroposterior plane. Confirmation by computed tomography (CT) was required only if the AAA was suspected to involve the renal vessels or if there was a complication. Elective surgery was offered to low-risk patients when the AAA measured more than 5 cm in diameter or when the patient was symptomatic irrespective of the size of the AAA.

A prospective database was kept on all patients with AAA. The data included patient age, sex, ethnic group, date of diagnosis, area of residence, mode of presentation, co-morbid risk factors and treatment outcomes. Eighty-five surgical cases were available for analysis in this study from July 1996 to December 2001. Each patient was classified into one of three categories on admission: elective repair; urgent repair within 24 to 48 hours for symptomatic patients; and emergency repair for ruptured aneurysms. Patients with recent onset of abdominal and/or back pain and aortic tenderness, with no possible causes other than AAA, were classified as having symptomatic AAA. This group included all patients with complications that required urgent attention, such as peripheral lower limb ischaemia, mycotic aneurysm and clinically impending AAA rupture. Ruptured AAA was defined as AAA in the presence of retroperitoneal and/or intraperitoneal blood in the absence of any other intraoperatively identifiable cause for the bleeding. Only mortality was studied because morbidities are more subjective and not applicable for P-POSSUM analysis.

All cases were scored using the 12 physiological and six surgical factors. The data were recorded manually on printed forms and subsequently transferred to a Microsoft Excel® spreadsheet (Microsoft Corporation, Washington, DC, USA) for analysis. The risk of death, R, was calculated using the P-POSSUM equation as follows: P-POSSUM $\ln[R/(1-R)] = -9.065 + (0.1692 \times \text{physiological score}) + (0.1550 \times \text{operative score})$.

The predicted and observed deaths were assessed using linear analysis[10] and the Chi-squared test, respectively. Values of p less than 0.05 were considered statistically significant.

Results

AAA repairs were performed in 85 patients: 40 were elective, 22 were urgent for symptomatic non-ruptured AAA (9 had recent onset of increasing pain with aneurysm tenderness, 4 had peripheral thromboemboli, 1 had inflammatory AAA, 1 had intestinal bleeding, and 7 had mycotic AAA), and 23 were emergencies for ruptured AAA. The median age was 70 years and the male to female ratio was 3.5 to 1.

There were 13 deaths within 30 days of surgery. The comparison between the number of deaths predicted by P-POSSUM and that observed for the different predicted risk groups is shown in Table 3. Table 4 shows the comparison between the P-POSSUM predicted deaths and observed deaths for the different categories of surgical urgency. There were no significant differences among the groups.

Discussion

Fair comparison of surgical results must take into account the differences in case-mix. POSSUM was developed as a surgical

Table 3. Comparison of predicted and observed deaths in different risk groups

Range of predicted mortality (%)	Mean predicted mortality (%)	No. of patients	Predicted no. of deaths	Observed no. of deaths	Ratio of observed to predicted no. of deaths
> 0–5	2.7	28	1	0	–
> 5–15	7.1	21	1	1	1
> 15–50	25.5	17	4	3	0.8
> 50–100	68.4	19	13	9	0.7
> 0–100	22.8	85	19	13	0.7

$\chi^2 = 0.78$, $p > 0.5$, degrees of freedom = 4.

Table 4. Comparison of predicted and observed deaths in different surgical urgency categories

Category	Mean predicted mortality (%)	No. of patients	Predicted no. of deaths	Observed no. of deaths (%)	Ratio of observed to predicted no. of deaths
Elective	5.1	40	2	2 (5)	1
Urgent	19.5	22	4	4 (18)	1
Emergency	57.7	23	13	7 (30)	0.5
Total	22.8	85	19	13 (15)	0.7

$\chi^2 = 0.70$, $p > 0.5$, degrees of freedom = 3.

auditing tool for the assessment of the quality of surgical care.[9] It allowed comparison of the audits of different patient populations by taking into account variations in the physiological conditions of patients at surgery and the extent of surgical intervention or severity of surgery. The original POSSUM equation for mortality prediction was subsequently modified to the P-POSSUM equation. The P-POSSUM equation produced a closer fit with observed in-hospital mortality in low-risk groups, and the comparison between the observed and predicted mortality rates was easier to perform using linear rather than exponential analysis.[10]

We found that similar results to those seen in established vascular units in the West for AAA repair can be achieved in a developing unit in Asia. The observed elective, urgent and ruptured AAA repair mortality rates of 5%, 18% and 30%, respectively, were comparable to the corresponding rates of established units.[13–15] In addition, the application of validated P-POSSUM scores that showed no difference between predicted and observed deaths confirmed that the results achieved were on a par with the standard of surgery seen in established vascular surgery units. This is important because recent trends in vascular surgery in the West have moved towards regionalization and centralization of resources. Acceptable results achieved in "young" Asian vascular units provide justification and accountability in these often marginally staffed units. It is stated that "the quality of surgical training is the single most important factor in reducing intra-surgeon variation."[16] As the structure of surgical training improves, all surgeons should be trained to deliver the best quality of clinical care possible. A well-trained and supervised trainee should be able to obtain results equal to that of a senior surgeon.[16]

The calculation of the POSSUM score requires basic data on physiological and surgical factors, the collection of which is well within the capacity of any developing surgical unit. Furthermore, the P-POSSUM linear analysis is simple to apply. Preliminary analysis using only physiological factors may be as predictive as using both physiological and surgical factors.[11] If validated by a larger body of data, this would further simplify data collection and may provide predictive power for surgical mortality preoperatively; this would be useful for informed consent as more information is provided regarding the expected surgical result.

The POSSUM score with the P-POSSUM mortality equation is a valid tool for comparative auditing of vascular surgery units in Asia. All vascular surgical units are encouraged to use this comparative tool for objective evaluation of their surgical results in this era of increasing public scrutiny and accountability of clinical surgery.

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